



Moments of Inertia

**Uninhabited Aerial Vehicle (UAV)
Dryden Remotely Operated Integrated Drone (DROID)**



**Presented by Helida C. Haro
August 6, 2010**





Agenda

- Personal Background
- Research
 - Importance
 - Measure, Weight, and CG
 - Design
 - Manufacturing
 - Hangar
 - Safety
 - Approvals
 - Test
 - Data Analysis
- Questions





Personal Background

- **Science Teacher And Researcher (STAR)**
- **California State University Northridge (CSUN)
Applied Mathematics Master Student**
- **CA Mathematics Council Member**
- **CSUN Mathematics Club Member**
- **National Science Foundation Scholarship Recipient**





Research



Figure 7, include the lengths of the vertical threads and the distance between the parallel bifilar. The inertia of the mounting





Mass Properties

The mass properties of an object are simply the proportionality constants between applied force and the resulting acceleration:

$$f = m\ddot{x}$$

This is Newton's 2nd law for 1 Degree of Freedom (DOF) translation and rotation, respectively

$$T = j\alpha$$

When expanded to 6 DOF:

$$\begin{array}{c} \text{Mass} \\ \text{6 DOF force} \end{array} \rightarrow \left\{ \begin{matrix} F_x \\ F_y \\ F_z \\ M_x \\ M_y \\ M_z \end{matrix} \right\}_P = \begin{bmatrix} m & 0 & 0 \\ 0 & m & 0 \\ 0 & 0 & m \\ 0 & -mZ_{CG} & mY_{CG} \\ mZ_{CG} & 0 & -mX_{CG} \\ -mY_{CG} & mX_{CG} & 0 \end{bmatrix} \left\{ \begin{matrix} \ddot{x} \\ \ddot{y} \\ \ddot{z} \\ \ddot{\theta}_x \\ \ddot{\theta}_y \\ \ddot{\theta}_z \end{matrix} \right\}_P$$

CG information
Inertia Tensor
6 DOF acceleration





Importance

The inertial characteristics have direct consequences on:

Aerodynamics

Propulsion

Structures

Control





Measure, Weight, and CG



Moments of Inertia, UAV DROID
7 of 18





Design



Moments of Inertia, UAV DROID
8 of 18





Manufacturing

B 7 6 5 4 3 2 I

NOTES - UNLESS OTHERWISE SPECIFIED:

- INTERPRET DRAWING PER ASME Y14.100
- MATERIAL:
 - Sheet, Al Alloy 6061-T6 per QQ-A-250/11
 - Plate, Al Alloy, Any Type Acceptable
 - Angle, Al Alloy 6061-T6 per QQ-A-200/1B
- MACHINED SURFACES SHALL BE 125 MICROINCHES MAX
- MACHINED FILLET RADII SHALL BE .010 MAX
- REMOVE ALL BURRS AND SHARP EDGES
- IDENTIFY WITH IJYR2--I AND LATEST REVISION LETTER PER MIL-STD-139. HANDWRITTEN, PERMANENT INK IS ACCEPTABLE. LOCATE APPROXIMATELY AS SHOWN
- CHEMICAL CONVERSION COAT PER MIL-DTL-5541, CLASS IA
- PROVIDE FOR CLASS FM 1 INTERFERENCE FIT [.00010-.00075] OF ITEM NO. 8 IN TD ITEM NO. 3
- NOT FASTENED TO ASSEMBLY IN VIEWS SHOWN

-1 INERTIA SWING FIXTURE
ISOMETRIC VIEW
SCALE: NONE

DETAIL A
SCALE 1:000

LINE	ITEM	DESCRIPTION	DATE	DRAWN BY	REVISION
1	-	APPROVED FOR INITIAL RELEASE	2018-03-15	M. J. B.	J. A. B.

-1 INERTIA SWING FIXTURE
BROKEN VIEW
SCALE: 1:000

LINE	ITEM	DESCRIPTION	DATE	DRAWN BY	REVISION
1	1	BARREL, FLAT			
2	2	BOLT, MACHINE, AIRCRAFT			
3	3	S4454	53155323	BALL BEARING	
4	4		MS2144-005	WIT, SELF-LOCKING, HEXAGON	
5	5		A18-1A	BOLT, MACHINE, AIRCRAFT	
6	6	-0	SPACER		2B, T, B
7	7	-7	BU		2B, T
8	8	-0	ANGLE		2C, T
9	9	-3	BRACKET		2A, T

ITEM NUMBER OR CAGE CODE PART NUMBER OR DESCRIPTION SPECIFICATION
ITEM NUMBER OR CAGE CODE PART NUMBER OR DESCRIPTION SPECIFICATION

ITEM	DESCRIPTION	REVISION
1	INERTIA SWING FIXTURE	I
2	SEE NOTE A	
3	NOTE	
4	NOTE	

RATE LIST

ITEM	DESCRIPTION	DATE	DRAWN BY
1	INERTIA SWING FIXTURE	2018-03-15	M. J. B.
2	SEE NOTE A	2018-03-15	M. J. B.
3	NOTE	2018-03-15	M. J. B.
4	NOTE	2018-03-15	M. J. B.

INERTIA SWING FIXTURE
IJYR2 GEN-00052
SHEET 1 OF 1





Shuttle Hangar



Moments of Inertia, UAV DROID
10 of 18





Safety

- **Human Hazard Analysis**
- **Loss of Asset/Mission Hazard Analysis**





Approvals

- **Critical Design Review (CDR)**
- **Tech Brief**





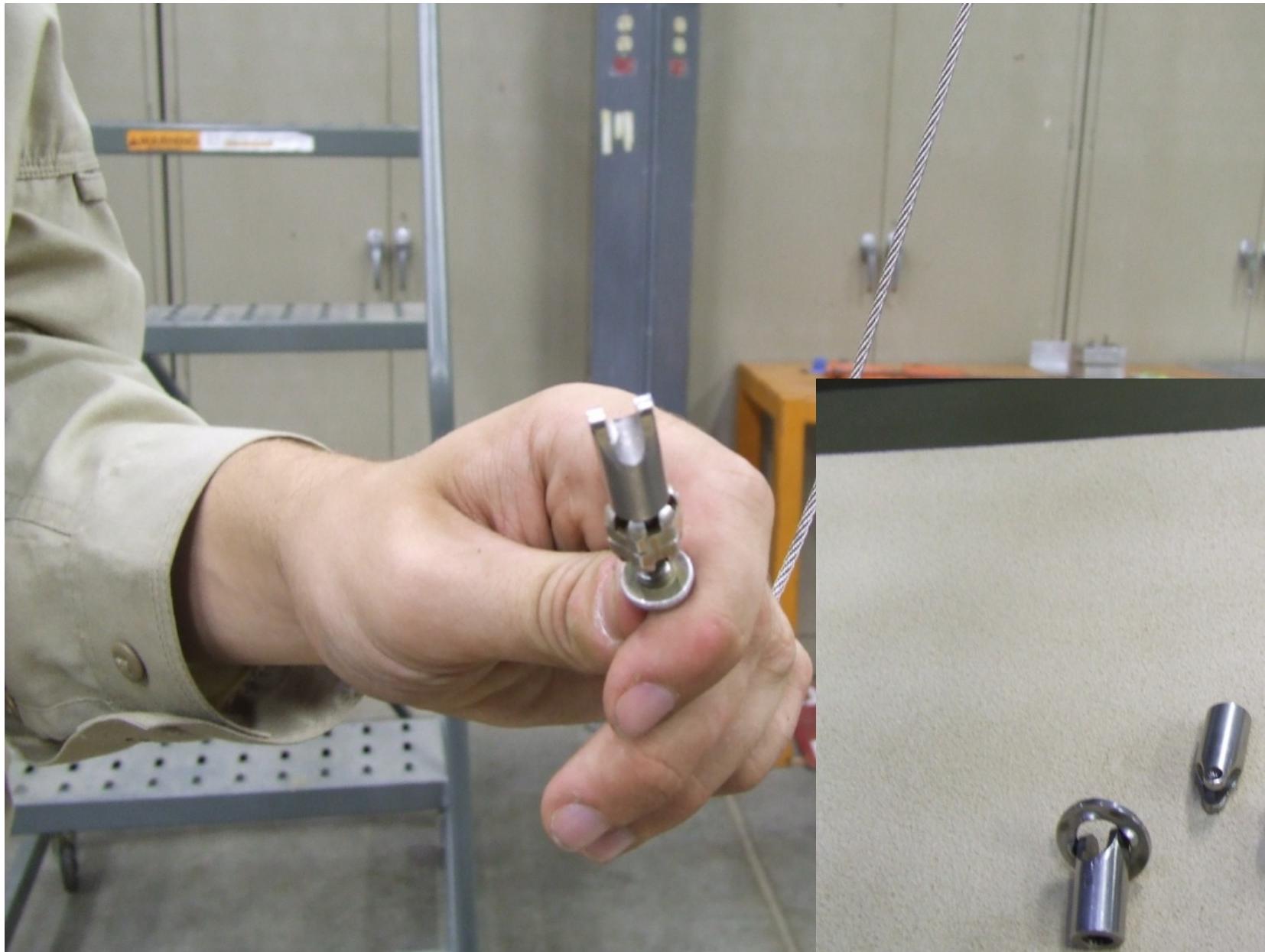
Testing











UAVSAR Longitudinal Center of Gravity
17 of 10

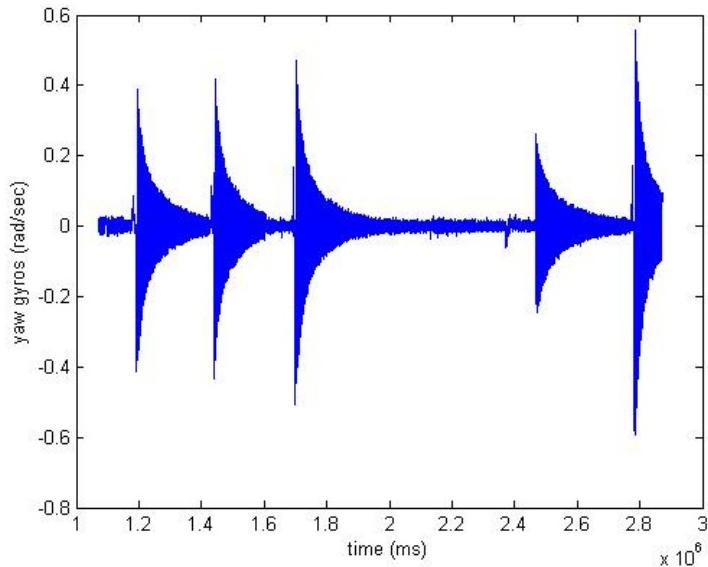








Data Analysis



- **Time Constraints**
- **Basic Geometric Shapes**
- **MATLAB**
- **Coupling**





Questions?



Mark, Chris, Aaron, Lesli, Stephanie, Alex, and Helida

All photos provided by: NASA photographer, Thomas P. Tschida and INSPIRE Team

Moments of Inertia, UAV DROID

22 of 18

